UCRL-JC-123996 Abs

BURN RATE OF AP/AL/HTPB PROPELLANTS AT HIGH PRESSURES

Jon L. Maienschein, Chet G. Lee,
Jeffrey B. Chandler, Jeffrey F. Wardell
Lawrence Livermore National Laboratory

The burn rate of propellants at pressures greater than those normally found in rockets or missiles can play an important role in the stability of the response of the propellant to upsets during the burning process. In addition, impact upon propellants or impact of propellants onto a surface can generate quite high pressures in the propellant; the pressure dependence of the burn rate can play an important role in the energy release and violence of reaction that results.

Here we report linear burn rate measurements on AP/Al/HTPB propellants at pressures above 70 MPa (10,000 psi), where very few data currently exist. We use the LLNL High Pressure Strand Burner to directly measure linear burn rates. In this apparatus, a 6-12 mm diameter sample up to 60 mm long is ignited at one end. A flame-inhibitor coating restricts burning to the exposed cross-section. The burn rate is measured by the time of arrival at different locations in the sample as indicated by melting of embedded wires, and the pressure is recorded by a load cell. We also embed a thermocouple in the propellant sample, and obtain a temporal temperature profile as the burn front approaches; this allows calculation of the thermal diffusivity of the sample under burn conditions. The pressure vessel is of small volume, such that the pressure increases by a factor of 2-4 during a single experiment; therefore in a single experiment we obtain the linear burn rate as a function of pressure. Although the pressure vessel will withstand pressures up to 1 GPa (150,000 psi), we keep pressures significantly below this with the AP/Al/HTPB propellants; this is required by the construction of key components in the strand burner with corrosion-resistant but low-strength materials.

A significant feature of our method is the direct determination of burn rate by measuring the time when the flame front reaches different locations in the sample. We do not rely on a calculated equation of state for the combustion products, and temperature losses to the pressure vessel do not affect our burn rate measurements.

We will present burn rate data on propellants containing 86-90% solids with 66-70% AP, 19-20% Al, and 10-14% binder.

*This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.